ALL ABOUT MALARIA

Causes • Prevention • Cure

Dr O P Jaggi, M D Ph D
FCCP (USA) FACA (USA) FRAS (London)



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All About Malaria

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Preface

After a lapse of more than two decades malaria has reappeared over large parts of India More and more cases of the disease are being reported The whole situation causes concern because the means available to check the spread of malaria are proving less and less useful

In the situation in which we are today, it is necessary to know the basic facts about malaria how it is caused how it is diagnosed how it is treated and the most important of all how to protect oneself from getting it

This book is intended to inform you about these and other aspects of malaria so that you can protect yourself and others from this disease

By no means it is intended that by reading it you can do away with the advice of a competent doctor in case it is necessary

CONTENTS

1

The Mosquito

The mosquitoes that we encounter in our surround ings belong to different species There are about 2700 species of mosquitoes known all over the world Many of these species act as carriers of different diseases The four important groups of mosquitoes in India that cause diseases in man are the Culex Aedes Mansonia and Anopheles

Malaria is caused in man only by the anopheles species of mosquitoes Forty five species of anopheles moqsuitoes have been identified in India The species of anopheles that carry malaria are six of these the most prevalent ones are A culicifacies pre-

dominently present in the rural areas and A stephensi predominently present in the urban areas

In order to understand how anopheles mosquitoes carry malaria to man and how this propagation of disease can be checked it is necessary that we get familiar with how the mosquito breeds through what stages of growth it passes what are its habits and also its anatomical structure

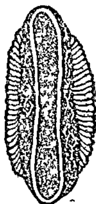
You might have seen that when you change flowers in a flower vase after some days or when you do not use your air cooler for some days you find in the water moving objects of different sizes and shapes some long and cylindrical moving fast from the surface to the depths others stout and stumpy which tumble down in water when disturbed These are the different stages in the development of mosquitoes which you unintentionally harbour in your own house and which when they become adults are the source of nuisance and disease first for you and then for your neighbours

In order to become adult insect the mosquito passes through four stages of growth (1) the egg (2) the larva (3) the pupa and (4) the adult Let us have a look at the characteristic features of each of these stages in an anopheles mosquito

The Egg

Anopheles eggs are deposited singly too small to

be seen with the naked eye Under the microscope they resemble tiny boats broadest at the middle with the ends somewhat pointed and the upper margins frilled In the mid portion on either side are structures which keep the egg afloat The eggs have a tendency to cluster together with the ends in contact, forming triangular polygonal or stellate patterns on the surface of the water



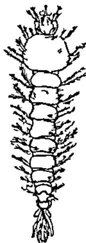
Anopheles Egg

A mosquito egg is entirely passive It takes no food has no power to move and survives or perishes depending upon the environments Most eggs hatch within 48 hours of laying Moisture and temperature

between 18 25°C tend to increase the survival of the eggs

The Larva

It is a free swimming creature This is the one you see occasionally swimming about in the water in the flower vase It has an elongated body divisible



Anopheles Larva

into head thorax and abdomen It passes through four stages of growth with moulting between each

stage Anopheles larva floats horizontally in water and has no siphon tube at the tip of its abdomen The whole larval stage occupies 5 to 7 days

Different environmental factors influence the development and behaviour of larvae in their breeding places The more important ones are the presence of other vegetable and animal life water movement and temperature sunlight and shade chemical composition of water, its turbidity and contaminants Anopheles larvae are more frequently found in association with some types of water plants Some anopheles grow in tree holes and under fallen leaves

Some varieties of fish such as guppy and gambusia eat up mosquito larvae In fact, they have been extensively used in some parts of India so as to check the number of mosquitoes

Larvae are vulnerable to wave action on water Constant agitation by wind man or beast may keep a potential breeding place free from larvae The flush tanks on top of the houses in the cities if they are working properly and frequently do not usually allow the mosquitoes to flourish there if they don t the mosquitoes breed in them Shady though not completely dark places in water encourage the growth of larvae Anopheles larvae do not like very low temperatures

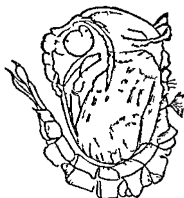
Since anopheles larvae are generally found in clean water in the villages if you ask a villager where he gets his drinking water there you

would find the breeding place of local malaria causing mosquito Clean water, however is not absolutely essential for anopheles growth

Anopheles larvae spend most of their time on sur face They appear to ingest anything that comes their way The bulk of larval food consists of algae and other small animal and vegetable life

The Pupa

It is a grotesque comma shaped structure in appea rance quite unlike larva It has a large rounded struc



Anopheles Pupa

ture which represents head and thorax and a narrow

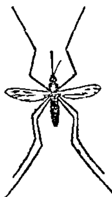
abdomen Two small respiratory tubes or trumpets project from the upper surface of the thorax The eyes wings legs and antennae of the adult mosquito are all more or less visible through the somewhat transparent covering layer At the end of the abdomen are the two tail fins or paddles by means of which the pupa is able to swim down ward through the water in a peculiar tumbling fashion

The pupa takes no food But it swims with consi derable agility It normally floats on the surface of water Sudden disturbance even vibrations send it tumbling down to the depths of the water As the pupa reaches maturity it becomes more susceptible to any disturbance Any activity around a breeding place interferes with the emergence of adults and causes high mortality

The Adult

When the development is complete the skin of pupa splits along the back and the adult mosquito emerges The process is completed in two to three minutes but the mosquito remains resting on the pupal skin case for several hours before attempting to fly During this time the natural colours of the species become fixed and the outer covering becomes relatively hard and dry

Under favourable conditions of temperature and



Anopheles Adult

food supply the life cycle from the egg to the adult is completed in 7 to 10 days

Behaviour Characters of Adult Mosquito

Following emergence from the pupal case the anopheles mosquitoes usually resort to sheltered resting places where they remain inactive for some time Relatively dark places free from wind not too dry are the most preferred ones The first resting places are in close proximity to breeding places and here both sexes are found in equal numbers Within

the house the mosquitoes often rest in dark corners and lower portions of the walls In villages cattle sheds are the preferred places both by day and night

The first flight of a mosquito from a breeding rea to a suitable resting place is usually very short There after the mosquitoes both male and female fly considerable distances They can cover a distance of upto two miles in about two hours

The male proboscis is not adapted for piercing so that it feeds only on flower nectar plant juice and water

Only the female mosquitoes bite Some species of mosquitoes that attack man, announce their inten tion by an annoying hum They cause pain at the moment of bite and give rise to subsequent itching and swelling No such crude act is indulged in by anopheles A majority of the female anopheles mos quitoes make a silent approach and their bite is hardly detected

Increased humidity and wet perspiring skin attract the mosquitoes for biting The peculiar odour of the human skin seems to attract them

Mosquitoes suck at a time blood even larger than their own weight A 2 mg mosquito after suck ing blood may weigh even upto 5 mg

Biting activity of anopheles mosquitoes is maximum between 10 p m and 2 a m The young and little older mosquitoes have more or less equal biting

ability A blood meal on the first day of the life of the mosquito is said to increase its longevity

The mosquitoes produce sounds while flying This sound is produced essentially by the rapid movement of the wings and changes in the outline of the thorax due to action of the wing muscles These sounds have significance inasmuch as swarming mating and mass migration are believed to depend upon auditory communication between individual males and females It has been suggested that artificial imitation of such sounds in connection with the operation of mosquito traps might serve as a possible control measure by luring larger numbers to their death The voices of the females are said to be deeper in pitch The voice of a single female can cause males of the same species to burst into a chorus The males orient themselves by turning either the antennae or genitalia in the direction of the source

Why do mosquitoes swarm over your head in the evening when you are outdoors moving along with you as you move? Swarming of the males occurs as a preliminary to the mating act The swarms tend to hover over some tall object such as a tree shrub building or a moving object Females invade the swarm momentarily emerging almost at once united with a male Pairing in A stephensi a common anopheles usually takes place end to end though there are many variations of position Mating pairs may remain in flight for a short while perhaps

until they encounter some surface on which they may come to rest. More commonly however the two fall to the ground where they may rotate like a whirling ball before separating and then flying away

One mating is usually regarded as sufficient for the functional life of the female though in some species there may be repetition of the mating act.

Anopheles lay their eggs on the surface of the water This occurs normally at night or in some species just before sunrise In many species the female rests either on the surface film or on a bit of floating debris, and proceeds to extrude the eggs one at a time upto a total of 100 to 350 The eggs soon float apart and assume interesting geometric shapes. Before laying eggs in some species, the female makes a hovering dance close to the surface of water A blood meal is usually necessary for the production of viable eggs

Male mosquitoes have a shorter life-span as compared to the females Temperature and humidity greatly influence the life span In hot summer anopheles have been seen to die in two days Both high and low temperatures are fatal. The usual life span of mosquitoes varies from 10 to 30 days

Anatomical Structure of the Mosquito

The body of an adult mosquito consists of three

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The Malaria Parasite

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Let us get familiar with the parasites of malaria so that by recognising them and their potentialities we can take suitable steps in either not getting the disease or having once got it take measures to get rid of them from the body

The number of known species of malaria parasite in man and animals is around 120 Only four species occur in man These are (1) P vivax (2) P falcipa rum (3) P malariae and (4) P ovale Of these P vivax has the widest distribution

In India 65 to 69 per cent of malaria fevers are reported to be due to P vivax 25 to 30 per cent due to P falciparum of these 4 to 8 per cent are mixed infections with both P malariae has a restricted distribution and is said to be responsible for less than 1 per cent of the infections in India P ovale is a rare parasite of man

Life Cycle of Malaria Parasite

The four species of malaria parasite in man differ from one another in structure but the general course of their life history is more or less similar The mala ria parasite undergoes two cycles of development (1) the human cycle and (2) the mosquito cycle

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The Malaria Parasite

Only a female anopheles mosquito which has earlier bitten a malaria patient is in time, in a position to pass on the disease to another human being whom it bites subsequently In the blood of a malaria patient are present the parasites of malaria which are the real cause of the disease These parasites in the scientific language called plasmodia grow inside the body of the mosquito Only after they have grown and multiplied in the mosquito and changed into another stage of the plasmodium are they capable of causing the disease in man

The mosquito thus performs a very important

function in the causation of malaria by (1) letting the malarial parasite grow in its body and (2) passing it on to another person The real culprit is the malaria parasite

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Cycle in Man

This cycle begins when an infected mosquito bites a person and through its proboscis injects the mala ria parasites in its developmental stage called sporozoites The sporozoites are slender fusiform bodies The number of sporozoites present in a single mos quito varies from perhaps a few hundred to several thousand When a mosquito feeds the sporozoites which are mainly in the salivary glands are introdu ced into the body with the salivary secretion Since the mosquito usually probes about with its probos cis until it strikes a small capillary the sporozoites are likely to be introduced directly into the blood stream and thus widely and promptly dispersed



Sporozoites

The first phase in their development in human beings is in the liver cells Here they reach from the

blood stream within half an hour of the bite of an infected mosquito and thereafter are no longer to be found in the peripheral blood They develop divide and mature in the liver cells for about 8 days *in* the case of P vivax and 6 days in the case of P falciparum At the end of this development, these liver cells burst and out come the parasites which are now called cryptozoites The stage when for the first time development of parasites occurs in the liver cells is *called primary exoerythrocytic stage* The cryptozoites in all the species of malaria parasite except P falciparum reinvade the other liver cells This stage is called secondary exoerythrocytic stage The two stages together being called the tissu stages It may be noted that the secondary exoery throcytic stage does not occur in P falciparum *Further development of the parasites now occu* inside the red blood cells (erythrocytes)

The third phase begins when the cryptozoit attack and enter the red cells in the blood Th *initially appear in these cells* as minute blob whi soon takes the shape of a ring The young troph zoite grows from the ring stage and in the case P vivax especially shows a good deal of mobility i side the red cells Eventually it tends to round and becomes less active This rounded form is call schizont Stained preparation of the blood at th time shows that nuclear substance the chromatin *the parasite* and the cytoplasm begin to divide, a

separate masses form which on maturity are termed as merozoites Thus again for the second time—first time in the liver—the malaria parasite has divided and increased in number

Now the infected red blood cell bursts and out come the merozoites in the blood They pick up the nearest red blood cell and enter it and restart the cycle of division and increase in number—schizont formation—which again in time burst and more numbers of merozoites attack fresh red blood cells This process may go on for days and months until the patient is treated or the immune response terminates further growth of the parasite This stage of development is called the erythrocytic stage as it occurs within the red blood cells

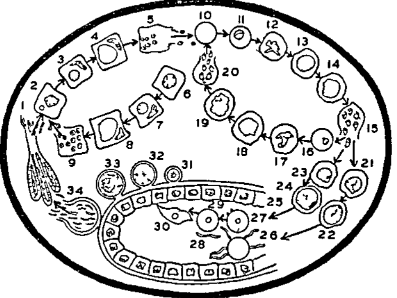
Some of the merozoites upon entering the red blood cells do not proceed through the cycle of schizont formation but proceed towards forming what are called the gametocytes the sexual forms of the parasite the trophozoites and schizonts are the asexual forms Male gametocytes are smaller and are thus called microgametocytes and female are slightly larger and called macrogametocytes More and more gametocytes are formed in the later course of the disease in man Female gametocytes in the blood are much more in number than the male ones

In P vivax infection gametocytes appear in the blood 4 to 5 days after the appearance of the asexual zoites in P falciparum infections they take 10 to 12

days more The gametocytes are incapable of developing further in the human They can only develop now in the mosquito

Mosquito Cycle

When a female anopheles mosquito bites a man who contains in his blood besides the asexual stages the gametocytes also further development of the gametocytes begins The asexual stages disintegrate in the stomach of the mosquito Within ten or fifteen minutes the male gametocytes throw out 4 to 8 thread like filaments called microgamete the process being called exflagellation These remain attached to the parent cell for a few minutes whipping about actively until they are liberated and swim away seeking the female gamete The whole process can also be observed in blood on a glass slide under a cover slip When a male gamete comes in contact with a female gamete it enters into the latter thus fertilising it The resulting product called zygote becomes elongated and is called travelling vermicule or ookinate It is mobile It penetrates the inner stomach wall of the mosquito and develops into an oocyst on the outer surface of the stomach Maturation of the oocyst takes a variable amount of time depending on the temperature species and perhaps on the individual mosquito A minimum of ten day s time is required



Life Cycle of Malaria Parasite

Life Cycle of Malaria Parasite

1 Sporozoites from salivary glands of mosquito entering liver cells
2 Liver cell containing early stages of primary exoerythrocytic parasite
3 & 4 Stages in development of the primary exoerythrocytic schizont in liver cells
5 Fully developed primary exoerythrocytic schizont rupturing and releasing cryptozoites
6 Liver cell containing cryptozoites of secondary exoerythrocytic cycle of the parasite
7 9 Stages in development of the secondary exoerythrocytic schizont in liver cell
10 Red blood cell
11 14 Stages in erythrocytic development [of the parasite
15 Fully developed erythrocytic schizont rupturing and releasing merozoites and gametocytes
16 20 Repetition of erythrocytic schizont stage
21 & 22 Development of male gametocyte or microgametocyte
23 & 24 Development of female gametocyte or macro gametocyte
25 Stomach wall of the mosquito
26 Exflagellating microgametocyte producing microgametes
27 Macrogamete
28 Free microgamete
29 Zygote formed by fertilization of macrogamete by a single microgamete
30 Ookinete
31 Oocyst
32 & 33 Stages in the development of oocyst
34 Rupture of mature oocyst with release of sporozoites
35 Salivary glands of mosquito containing sporozoites

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Symptoms of Malaria

Between the bite of an infected mosquito and the appearance of symptoms of malaria in the bitten person there is a time period du ... which the para in the body Th ... is called the For P viva ... is 10 to P falciparum ... for P to 40 days ... in the ... the diff ... on the

cells containing the mature schizonts of the malaria parasite rupture liberating into the blood the merozoites the malarial pigments and other material contained in the schizont It is the appearance of them in the blood that causes a paroxysm of fever

Classical Malaria Attack

The classical malaria attack has a sudden onset followed by four well marked stages (1) Cold (2) Hot (3) Sweating and (4) Apyrexial Interval when there is no fever

Cold Stage

The patient first experiences a chill or rigor during which he feels very cold although his temperature is rapidly rising Shivering may be so marked as to rattle the bed Teeth chatter the skin is dry features pinched the extremities bluish tinged The patient curls up in bed covering himself with all available blankets and still feels cold The pulse is rapid but diminished in volume There may be headache nausea and vomiting This stage lasts from half an hour to about two hours

Hot Stage

As shivering ceases the patient begins to feel hot

3

Symptoms of Malaria

Between the bite of an infected mosquito and the appearance of symptoms of malaria in the bitten person there is a time period during which the para site grows in the body This interval is called the incubation period For P vivax infection it is 10 to 15 days for P falciparum 8 to 12 days for P malariae it is 30 to 40 days The difference in the incubation period of the different species of the mala ria parasite depends on the inherent difference in the human cycle of these parasites and the dose of infection of sporo zoites

An attack of malaria fever occurs when red blood

cells containing the mature schizonts of the malaria parasite rupture, liberating into the blood the merozoites the malarial pigments and other material contained in the schizont It is the appearance of them in the blood that causes a paroxysm of fever

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Hot Stage

As shivering ceases the patient begins to feel hot

He discards the covers His face is now flushed eyes are suffused skin remains dry but hot and instead of appearing blue it may have a slightly pale tinge The pulse is full and bounding respiration rapid He suffers from increased headache rapid respiration parched throat coated tongue great thirst nausea and sometimes vomiting Slight delirium or euphoria may be noted Temperature may rise to 40 C or even higher during this stage This may last from 1 to 6 hours unless cut short by drugs

Sweating Stage

Rather suddenly the patient begins to perspire profusely first on face and hands then from every pore drenching garments and sheets He feels a great sense of relief his headache and vomiting cease his pulse becomes more normal he feels tired and drowsy and usually falls asleep with tempera ture normal or perhaps a little subnormal The sweating stage lasts 1 to 2 hours

The Apyrexial Interval

Following the sweating stage there is an interval of normal or slightly subnormal temperature when the patient may want to get up and carry on his usual activities although he is frequently somewhat pale weak and irritable with a poor appetite

After this apyrexial interval will come another cycle of chill fever and sweating unless the patient is treated in the meanwhile Treatment may limit an attack to one or two cycles Untreated patients may continue to have rigors for 10 days or longer before the infection lies low

The periodicity of fever is dependent on the plasmodial cycle since rigors coincide with the bursting of schizonts present in the red blood cells

Each of four causative species of malarial parasite presents its own characteristic features which are as follows

Vivax Malaria (Benign Tertian)

While first attacks may be classical from the onset, it is more common in a primary episode to see a daily rise in temperature in P vivax infection before the 48 hour periodicity becomes established Such daily rise of fever may be due to two brods of parasites coming out of the liver cycle The fever may rise upto 39 C and above Cerebral symptoms are not common in P vivax malaria but one sometimes encounters dizziness drowsiness transitory disorientation or syncope Intestinal symptoms are also likewise not the rule aside from some abdominal discomfort and occasional diarrhoea

Spontaneous relapse is usual in vivax malaria, frequently within one month but sometimes consider-

ably delayed There is much greater tendency for vivax malaria to relapse than in the case of falciparum infections But vivax malaria is seldom fatal, even when untreated

In children vivax malaria often does not show typical periodicity The fever may be slight and irregularly discontinuous Convulsions are more common than in adults Progressive anaemia and marked enlargement of the spleen are usual in untreated cases

Blood smears are generally positive throughout the apyrexial period in untreated cases

Malariae Malaria (Quartan)

The paroxysm occurs usually after 72 hours The paroxysm is generally no more severe than in vivax infection although the rigors may be more exhausting The paroxysms are generally more regularly spaced

This has marked tendency to relapse and this may lead to clinical episodes three or four or even more years after the infection was contracted Kidney involvement (nephritis) is reported to occur more commonly with this than with P vivax or P falciparum infection

Ovale Malaria (Tertian)

It resembles vivax infection but is milder with a

tendency to early latency and much less liability to relapse

Falciparum Malaria (Sub-Tertian or Malignant Tertian)

A frank chill may not occur in falciparum infections but only slight chilliness followed by a prolonged hot stage and much less sweating The paroxysm is likely to be more exhausting than that of either vivax or malariae Irregularity in the course of the paroxysm, which may last from 30 to 36 hours is typical of falciparum infections There is more prostration headache is more severe, vomiting more frequent mental confusion and stupor more common

There may not be a well marked apyrexial period Temperature may rise and fall gradually rather than suddenly A temperature of 39°C or more should be considered as a serious sign in falciparum malaria

Blood in falciparum infections may not show the parasites This is because the parasite infected red blood cells are held back in the capillaries of the spleen or other organs soon after young ring forms begin to broaden

Fulminant or Severe Malaria Attack

Fulminant attacks of malaria as a rule occur

only in recently infected individuals or those experiencing early relapses because such patients have not developed immunity to the parasite This occurs nearly always due to P falciparum as this species surpasses others in its ability to multiply and cause subsequent changes in the body

Under epidemic conditions fulminant attacks may occur both with P falciparum or P vivax

In fulminant infections the clinical picture may be grouped under three headings depending upon the predominant localization of symptoms and signs These are (1) the Nervous System (2) the Gastro-Intestinal System and (3) elsewhere

Cerebral Malaria

The onset of cerebral malaria varies greatly and may be gradual or sudden For instance a man may be seen in the out patient clinic in the morning without fever and complaining only of headache but he may be brought in coma with fever in the afternoon Patients may be found in malaria coma an hour or two after the ward rounds when they had seemed normally responsive Fever headache vomiting sighing respiration full rapid pulse stiff neck may be noted Other indications of cerebral malaria are excitement disorientation somnolence and coma The patient may be stimulated to answer

a question but then sinks back into deep stupor High fever and shock may develop.

Gastro-Intestinal Malaria

Intestinal localization of symptoms may lead to so-called algid or cold malaria with sudden collapse som times without other symptoms but more often associated with bloody vomitus muscular cramps suppression of urine and blood and mucus in stool. Cholera like symptoms may develop without a typical rigor or any of the familiar symptoms and signs of malaria

Malaria in Children

Malaria is rare in the first few months of life An acute attack of malaria in children does not resemble the disease in adults Fulminant forms are more often seen Besides P falciparum even P vivax is known to cause them The onset is often gradual the child becomes dull restless resenting feeding and often vomiting sometimes the vomitus being blood stained Abdominal pain flatulence and diarrhoea are common Temperature ranges between 38 to 40 C and the fever may be continuous or coming on at intervals Rigors are not common but there may be stiff neck and convulsions when the fever is high Anaemia develops more rapidly Death due to

fulminant malaria is more common in children than in adults

Malaria in Pregnancy

Malaria can prove serious in pregnancy It may cause miscarriage or abortion It may be an important predisposing factor of complications of pregnancy such as eclampsia Special care should be taken to protect pregnant women from malaria and to detect malaria in them and to treat it promptly

Although a majority of patients suffering from malaria present a characteristic triad of intermittent fever anaemia and splenic enlargement yet few diseases have as wide a range of clinical syndromes as malaria Factors such as epidemic conditions acquired immunity mixed infections with more than one species of malaria parasite previous clinical and suppressive treatment all modify individual response the clinical picture and the course of the disease

Malarial Emaciation

The most serious result of repeated attacks of malaria is malarial emaciation, which is characterized by severe anaemia emaciation and great phy[illegible]al
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spleen is

enlarged, sometimes extending into the pelvis The liver too is often enlarged The spleen is susceptible to rupture or to a twisting Loss of appetite and mild diarrhoea are common Anaemia may lead to shortness of breath and palpitation Amenorrhoea is not uncommon in women Abortion frequently occurs in the presence of malarial emaciation

Blackwater Fever

This is one of the manifestations of malaria occurring more often in previously unexposed people coming to reside in a malarial epidemic area There is fever for which the patient may have taken quinine A shortwhile later the patient passes dark red or black urine He has vomiting and pain in the loins Within a few hours more than half the number of red blood cells may get destroyed (haemolysed) Mild cases may recover but those who pass into the stage of cessasion of urine formation and shock may not recover

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The most serious result of repeated attacks of malaria is malarial emaciation which is characterized by severe anaemia emaciation and great physical weakness, a mental disturbance which is manifested chiefly as inability to concentrate poor memory and a tendency to be depressed The spleen is usually

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Pathological Changes in the Body

Changes in the body are initiated when the parasites invade the body and proceed to multiply within red blood cells Because of their localisation in the blood vessels of the internal organs P falci parum infections bring about marked pathological changes The changes produced may be described as follows

Blood

A constant feature of malaria is destruction of red blood cells This occurs when infected red blood

cells rupture after proliferation of the parasites in them It also occurs through engulfing (phagocytosis) of infected as well as normal red blood cells in the spleen and liver Red blood cell debris stimulates production of toxins which destroy further the red blood cells

In an acute malaria attack, the haemoglobin is generally reduced in amount in direct proportion to the loss of red blood cells Chronic malaria is more likely to be characterized by markedly reduced haemoglobin with a moderately reduced red cell count

Though changes occur in the white cells also except for the presence of malaria pigment in them these are not characteristic of the disease

In the plasma albumin is reduced and globulin increased The peculiar globulin increase sometimes causes the serological tests for syphilis to be positive This may remain so far as long as four weeks This phenomenon has to be properly understood otherwise it may lead to false diagnosis of syphilis

Spleen

One of the functions of the spleen is to recognize filter out and phagocytose old or abnormal red blood cells In cases of malaria, the spleen filters the parasitized red blood cells and the debris of the dead cells As the spleen has a lot of phagocytosing

work at hand in cases of malaria the cells which perform this function increase in number

During each paroxysm of malarial fever the spleen becomes swollen and tender Almost invariably in untreated cases it becomes palpable three or four days after the beginning of an acute attack It subsides rapidly during treatment and is thus not so frequently palpable in those who have had adequate treatment

Repeated infected infections result in a greater degree of spleen enlargement than that following a single infection even though attack periods are of equal duration After long continued malaria especially in *P vivax infections the spleen may weigh* as much as 5000 gms or more the average normal weight of spleen is around 200 gms The covering and the inside of the spleen shows characteristic microscopic changes in cases of malaria

Liver

Enlargement tenderness and impairment of liver functions occur in cases of malaria It changes in colour turning slaty blackish in appearance and firm even hard Microscopically liver structure shows characteristic changes in malaria

Capillary Occlusion

In case of falciparum malaria, there is an enormous proliferation of the parasites inside the red blood cells The masses of agglutinated parasitized red blood cells cause capillary blockage in many organs of the body These and other changes occur in the brain spleen liver and other organs as well

Brain

In fulminant infections with P falciparum cerebral malaria the capillaries are full of masses of parasitized red cells malarial pigment phagocytic cells and occasionally free parasites sometimes giving the appearance of thrombi or clumps Other changes in the brain consist of small haemorrhages and small degenerative foci

Characteristic malarial changes also occur in the gastro intestinal tract pancreas and the kidneys

Skin

Skin becomes pale sallow showing small patches of pigmentation Some patients with acute malaria have severe herpes labialis and others with chronic *malaria may have a considerable degree of urticaria* Petechial haemorrhages and sometimes purpuric spots are occasionally reported in malaria

5

Diagnosis of Malaria

The only certain diagnosis of malaria is made by demonstrating the malaria parasite This is done by making a thick and thin film of the patient s blood and after staining the blood film and examining of the same under the microscope

Blood Smear Examination

Living in a malarious area it becomes the duty of all responsible citizens to know how to make a blood slide A doctor may not be available when needed and a blood smear made at the time of

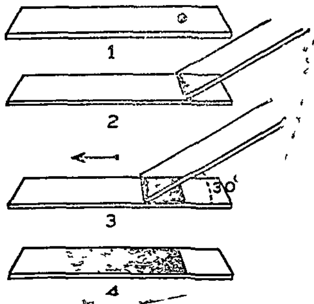
rigor or at any stage of the fever before treatment is given is necessary All it needs is keeping a few glass slides in the home and learning the simple technique

For making blood smears the material required is two clean glass slides a needle a cotton swab and methylated spirit

Clean the tip of the middle finger (or big toe in case of infants) with cotton swab soaked in methylated spirit and then let the spirit dry With a sterile needle or one which has been passed through flame and cleaned with spirit a sharp prick is given The finger tip is squeezed gently and if the prick given has been adequately deep out flows a thick drop of blood

For making of the blood film the glass slide should be meticulously clean free of dust grease and scratches A large free flowing drop of blood is allowed to touch on the outer third of the slide and is rapidly spread with the pricker to form a round or square thick smear about 1 cm in diameter This thick film should dry by itself without exposure to any undue heat and must be protected from dust flies ants and cockroaches

If possible a thin film should also be prepared on the clean part of the slide A small drop of blood is placed near the centre of the slide and the slide is laid on the table The blood is touched with



Making of a blood film

the narrow edge of another clean slide held at an angle of 30 As soon as the blood spreads along the edge this slide is pushed along the surface of the first slide to form a thin and even film

It is desirable to have the thick and thin film on the same slide as it allows for a better identifica tion of some species of malaria parasites and mini

mizes various technical errors

Blood films should be made even if they cannot be examined immediately

The malaria parasites are the greatest in number in blood a few hours after the rigor With P vivax infection blood smear is usually positive for the parasite but in P falciparum infections this may not be so Hence in a case of continuing fever which clinically is suspected to be that of malaria it is necessary that blood smears be examined repeatedly Reliance on negative results may lead P falciparum infections to the stage of coma

Since examination of blood smears takes time, considerable experience and devotion to work it is necessary that the technicians employed for the job be such that the reliability of their report can be depended upon

From the examination of blood smears in a malaria patient it is possible to establish the species of the infecting malaria parasite

Suggestive Clinical Findings

Clinical findings most constantly associated with malaria with or without a positive smear are

1 Fever especially when it comes up and goes down (intermittent) with rigor and sweating
2 Anaemia
3 Enlargement and tenderness of spleen The spleen may become palpable a few days after

onset of symptoms Sometimes there is tenderness of the spleen before the organ is palpable

4 History of potential exposure to infection or of previous malaria

The diagnosis of malaria cannot be ignored because of a typical symptoms Double or multiple infections with the same species of malaria parasite and mixed infections especially a combination of P vivax and P falciparum are common in times of epidemics These complex infections lead to a typical clinical picture

Irregular suppressive treatment also may greatly modify clinical picture The only symptoms may be persistent headache backache or eye disturbances with pain If all specific antimalarial treatment is withheld blood smears may become positive after 3 to 6 weeks at which time a typical attack of malaria may be witnessed

Differential Diagnosis

The diseases which may be kept in view in a case of fever and which should be excluded before a diagnosis of malaria is established are influenza dengue typhoid infectious hepatitis amoebiasis with liver abscess filariasis kala azar septic infections

Diagnosis of influenza is made upon the clinical symptoms and from the fact that an epidemic of it

is around Before making this diagnosis, it is essential that the blood be examined for malarial parasite if the patient is living in a malarious area Laboratory confirmation of the diagnosis of influenza takes much time

In dengue one frequently notes severe generalized muscle pain saddle-back seven-day fever curve, slow pulse lymph gland enlargement rash, marked fall in white blood cell count None of these occur in malaria As in a case of influenza diagnosis of dengue should be made only after exclusion of malaria

In typhoid fever one depends on early stool culture and later on Widal tests for definitive diagnosis Negative blood smears and lack of response to malaria therapy also help

Differentiation between malaria and the pre jaundice stage of infectious hepatitis may be difficult. Tenderness of the liver is more pronounced in infectious hepatitis

Amoebic abscess of the liver must be differentiated from malaria Enlargement of the liver without splenic enlargement rigidity of the right rectus abdominal muscle fever increase of white blood cells with 70 to 80% polymorphs all suggest the possibility of liver abscess Clinical response to specific treatment with emetine is another diagnostic point Confirmation of diagnosis by X rays or by an exploratory puncture may be possible

or marks of insulin injections on the patient s body

In alcoholic coma the patient smells of liquor In opium coma there is no fever

6

Anti Malarial Drugs

There would hardly be any substance or procedure that has not been used through the ages against malarial fevers 'From wearing a spider hung around one's neck in a nutshell or placing the fourth book of the *Iliad* under a patient's bed to taking snuff of a tallow candle on sugar bread and butter or seven sages leaves on seven mornings fasting and down the years through massive calomel purges to colloidal gold no suggestion has been too bizarre for written testimonial'

Malaria has invited this flow of therapeutic suggestions by reason of its great prevalence throughout the

world and because it is a disease that tends to be self limited The patient may recover from acute episodes without treatment or following the adminis tration of almost any medication

Yet the list of truly useful antimalarial drugs is a short one This includes quinine mepacrine chloro quine and amodiaquine primaquine and proguanil and pyrimethamine The following description indi cates for which stage/stages each of these drugs is effective The dosages toxicity and other relevant particulars are also given

Quinine

Quinine an alkaloid derived from cinchona bark interrupts the development of malarial parasites of all species and at all stages in the red blood cells, except those of gametocytes of P falciparum It has no effect on exoerythrocytic stages of the develop ment of the malaria parasites Now a-days it is chiefly used as the drug of choice in chloroquine resistant strains of P falciparum infections

Quinine is given orally as its sulphate at intervals of 6 to 8 hours as it is not stored in the body It is rapidly and completely absorbed from gastro intestinal tract Injected intramuscularly it is not more quickly absorbed than given orally but former is the route resorted to in cerebral malaria cases which are comatose Intramuscular injection can

produce extensive tisssue damage unless due care is taken Intravenous injection needs to be given very slowly it is likely to cause convulsions sometimes

The toxic symptoms produced as a result of giving quinine include one or more of the following tin nitus deafness dizziness changes in vision nausea vomiting diarrhoea urticarial rash These symptoms are usually mild and disappear after treatment is stopped But in case the drug is given in overdosage or continued too long permanent damage may occur to the ears and the eyes

Mepacrine

Synthesized in Germany in 1930 it gained world wide popularity Its action is like that of quinine It destroys all malaria parasites of all species develop ing inside the red blood cells except the gametocy tes of P falciparum gametocytes of P vivax disappear more rapidly from the blood after its administration as compared with quinine Because of its rapid destructive action on schizonts it tends to eliminate falciparum gametocytes by bringing an end to schizogony

Mepacrine given orally is rapidly absorbed in the blood It takes longer to attain optimal blood level as it has a tendency to localize in various tissues of the body

Mepacrine is relatively non toxic Some patients

may complain of anorexia salivation nausea vomiting diarrhoea headache and restlessness Prolonged administration gives a yellowish tinge to the skin

Because it causes yellowish tinging of the skin a longer time to reach optimum effective level in the blood its use has now a days been superseded by new more effective and less toxic drugs

Chloroquine and Camaquine

Chloroquine was first synthesized in Germany in 1934 and was named Resochin Both chloroquine (4-aminoquinoline) and camaquine (amodiaquine) like quinine and mepacrine are active against all species of malaria parasites in red blood cells except the gametocytes of P falciparum

They are not active against exoerythrocytic forms of the parasite In an acute attack they rapidly destroy parasites in the blood and abate the clinical symptoms in most patients temperature touches normal within 24 to 48 hours and blood smears become negative in 48 to 72 hours

Chloroquine and camaquine are rapidly and almost completely absorbed from the alimentary tract and are localized in various tissues from which they are slowly metabolized and excreted Given intramuscularly chloroquine becomes concentrated in the plasma in therapeutic amounts within 15 minutes

Chloroquine and camaquine have largely replaced

quinine and mepacrine in malaria treatment because (1) they act more promptly on the erythrocytic forms and thus bring down fever more quickly (2) they lengthen the period when the patient may not get a subsequent attack, (3) they do not tint the skin and (4) they have low toxicity

Primaquine and Pamaquine

Pamaquine (8 aminoquinoline) was synthesized after the First World War It is more toxic than primaquine though both have similar action on different stages of development of the malarial parasites

The speciality of primaquine is that it is active against secondary exoerythrocytic forms of P vivax Because of that it is the most important drug available for radical cure of vivax malaria after the fever has been halted Radical cure implies clinical cure plus elimination of malaria parasites from the liver so that relapses do not occur

Primaquine is rapidly absorbed orally and rapidly eliminated

Unfortunately primaquine is a fairly toxic drug Symptoms of primaquine toxicity include abdominal pain nausea vomiting headache dizziness and drowsiness Less common but more significant toxic effects are destruction of red blood cells (haemolysis) and passing of dark coloured urine as a result of that The tendency for haemolytic reaction following

7

Treatment of a Malaria Attack

In an area where malaria is known to occur commonly all cases of fever—after the blood smear has been made—are recommended by some doctors to be treated as malaria In the majority of the cases of malaria the fever thus comes down within twelve to twenty four hours It is only after the fever does not come down in this duration that the patient is investigated further In the meanwhile the result of the blood smear of the patient also becomes available so that if malaria is confirmed and the species of malaria causing the disease known a further course of action can be adopted if necessary

The initial treatment of a malaria patient is the same irrespective of the species of malaria parasite that is causing the disease Additional follow up treatment is necessary in the type of malaria where relapses are known to occur as in cases of P vivax and P malariae infections

For an attack of malaria either chloroquine (Nivaquine) or camaquine are the drugs of choice The National Malaria Eradication Programme (NMEP) recommends an adults dose of only four tablets of chloroquine or camaquine to be given at a time Fever comes down in twelve to twenty four hours in an acute attack of malaria

In case the patient is suffering from P falciparum malaria this is all that is required to be done In case it is found that the infection was due to any of the other three species particularly the P vivax—which is the most common infection in most parts of the country—then a further course of another drug namely primaquine in an adult dose of 15 mg a day for 5 days is recommended to be given after the fever has come down

The advantage of taking radical treatment with primaquine is that the patient suffering from these types of malaria ensures that he will have no relapses which weaken the patient very much and make him susceptible to other diseases

Primaquine in the doses prescribed rarely causes

severe toxic symptoms of red blood cells destruction Recognition of the defect in the metabolism of the enzyme glucose 6 phosphate dehydrogenase is an added precaution before this drug is given

If primaquine is given under strict medical care and the patient is cautioned to stop the drug and report at once to the doctor if nausea vomiting and dark coloured urine is passed the dangers of primaquine administration can be minimised

Quinine is not used now a days in the treatment of an attack of malaria unless the species of malaria infecting a patient is non responsive to chloroquine and has become resistant to it

Drug resistance is suspected when cases of malaria usually P falciparum infection do not fully and rapidly respond to standard treatment with chloroquine or when recrudescence of symptoms occur and parasites are seen in the blood soon after their temporary disappearance or coming to low level subsequent to therapy

The above mentioned drugs are bitter and should be given along with a drink of milk fruit juice other flavoured fluid or a glass of water after food and not on empty stomach Care must be taken to make certain that the patient swallows the tablets and they are not vomited out

As regards the general treatment of the patient during acute attacks of malaria the patient should remain in bed If body temperature rises above 39°C

ice cap or sponging is necessary Nausea may be alleviated by sucking ice Muscular pains are relieved by taking acetylsalicylic acid or paracetamol Fluid intake should be maintained at three or four litres daily and salt loss made up

Since the diagnosis of the disease can be made only by an experienced doctor his advice in the matter is essential Self medication is likely to lead to inadequate or incorrect treatment in a case of malaria in case it is not malaria it will lead to delay in correct diagnosis and complicate the case

If the advice of a doctor is not immediately available a person living in malarious area getting fever with symptoms akin to malaria may take 4 tablets of chloroquine as the fever comes up It is advisable that he makes a smear of his blood on a clean glass slide to be examined later on

8

Treatment of Cerebral Malaria

Irrespective of the species of malaria parasites causing the disease any severe malarial infection with cerebral symptoms vomiting pronounced nausea or defective absorption from gastro-intestinal tract requires parenteral administration of a rapidly acting anti malarial drug In P falciparum infection even though clinical symptoms may not be very alarming the patient should be treated as a medical emergency Preferably the patient should be transferred to the hospital for dealing with any complication that may develop with dramatic suddenness

Chloroquine and quinine are the best drugs for parenteral administration Intravenous injection acts somewhat more rapidly than intramuscular injection but presents a relatively greater risk in some patients Quinine is given if resistance of the parasite to chloroquine is suspected

For an intravenous injection 200 mg base of chloroquine diphosphate in 20 ml of normal saline or distilled water is injected very slowly and the injec tion completed in not less than 15 minutes If the patient is in a state of shock 200 mg of chloroquine diphosphate should be given by intravenous drip in half a litre of 5 per cent glucose saline If there is no appreciable improvement in 8 hours the second dose can be given

Unless there are good clinical indications for intravenous administration of chloroquine intramus cular route can be employed Chloroquine diphos phate 200 mg of the base should be made in 9 ml of sterile normal saline or distilled water and inject ed into gluteal muscle Readymade chloroquine (Resochin) ampoules are also available It can be repeated at 8 hourly intervals in first 24 hours

Intravenous quinine must be given in high dilution Quinine dihydrochloride solution is given in the adult dose of 8 to 10 mg of body weight (500 mg) diluted in 20 ml of glucose saline It should be injected very slowly in at least ten minutes If the

patient is in shock it should preferably be given as an intravenous drip in 0 5 litre of glucose saline This may be repeated if necessary after six to eight hours The total dose in 24 hours should not exceed 2000 mg

For intramuscular injection quinine hydrochloride 500 mg made in 9 ml of normal saline or distilled water is injected into gluteal muscle

As with many other drugs faulty technique of intravenous injection of quinine or chloroquine solution may produce local necrosis of surrounding tissues this risk is greater with quinine than with chloroquine

The proper technique of intramuscular injection especially that of quinine must be strictly observed After a thorough cleaning of the skin the drug should be given in the classic site of the upper external quadrant of the buttock deep into the gluteal tissue Sterile precautions must be strictly observed to avoid accidental contamination Quinine injections may produce local transient reactions which occasionally leave long lasting fibrotic indurations This is exceptional with chloroquin

Intravenous injections of any anti malarial drugs in children below seven years of age may be dangerous and should be avoided if possible Intramuscular injections should be given only when really necessary in severe infections requiring rapid treatment and the dosage of the drug must be based on

the weight of the child It is safer to give the drug in two halves separated by an interval of one to two hours Oral treatment of all cases of malaria should be preferred and used wherever possible

Shock coma or convulsions are promptly treated by standard procedures

In cerebral malaria the patient develops very high fever he should be wrapped in a wet sheet immersed in cold water and placed under a fan If possible he should be moved to an air conditioned room Injection paracetamol 0 5 gm intramuscularly is given, which can be repeated after 8 hours Temperature is recorded rectally

9

Drug Prophylaxis or Suppression of Malaria Attack

Drug prophylaxis or suppression implies prevention of clinical symptoms of malaria even though the person has been infected by malaria parasites This is resorted to in certain circumstances

A person bitten by an infected mosquito develops in his body exoery throcytic stages of the malaria parasites in the liver and also erythrocytic forms inside the red blood cells If he is not to get an attack of malaria the malaria parasite should be killed before the red blood cells containing merozoites burst forth

The drug commonly u ed for the [illegible] a days is chloroquine which [illegible] stages of all the species of mala[illegible] which kills parasites in erythro[illegible] cytic stages was given earlier for the purpose [illegible] is toxic after prolonged use and not [illegible] in India Pyrimethamine like paludrine [illegible] suitable drug but this needs to be taken [illegible] week Since repeated infections are liable to [illegible] in malarial areas the drugs need to be taken repeatedly

The drugs used for prophylactic purposes and their dosage schedule are as follows in adults and proportionately less in children

Chloroquine—300 mg (2 tablets) once a week
Proguanial (Paludrine)—300 mg tablet weekly
Pyrimethamine (Daraprim)—25 mg twice a week

The dose of chloroquine compared to the adult dose for children and infants is as follows children between 11—16 years 3/4 dose 7 to 10 years 1/2 4 to 6 1/3rd 1 to 3 years 1/4 and under 1 year 1/8th

A traveller passing through a malarious area should take prophylactic anti malarial drugs pre ferably one week before arrival or take initial double dose in 2 divided doses 6 hours apart

After leaving the malarious area it is very impor tant to continue drug prophylaxis for at least 4 weeks and preferably 6 to 8 weeks

Pregnancy is not a contraindication to the use of anti malarial drugs

At the appropriate dosage none of these drugs has any serious side effect

Drug phophylaxis is essential for more vulnerable groups such as children or pregnant women

Use of prophylactic antimalarials for each and every person living in a malarial area is not recom mended The symptoms and signs of malaria are fairly well recognized and an ordinary attack of malaria is not too serious a thing Why not take just 4 tablets of chloroquine when the fever occurs rather than to go on taking 2 tablets of it every week?

Difference of opinion on recommendation of drug prophylaxis does occur It seems that where and when malaria is less prevalent drug prophylaxis may be omitted if however the incidence of malaria is very high in a particular area and at a particular time so that the chances of frequent in fections exist drug prophylaxis may be taken regularly

10

Malaria Immunity and Vaccination

Immunity

Malaria whether treated or not tends to be self limited The primary attack may be followed by complete recovery or by a series of latent periods alternating with relapses the former tending to become progressively longer and the latter less and less severe until cure occurs In vivax malaria, it has been observed that a clinical attack usually terminates in the presence of a considerably higher parasite counts in blood than that sufficient to initiate the attack Most attacks occur with parasite

counts between 10 and 100 per c mm yet clinical activity usually terminates spontaneously at counts of from 1000 to 5000 parasites per c mm Furthermore, the onset of relapses is generally marked by con siderable higher parasite counts than seen in primary attack This shows an acquired state of immunity against the malaria parasites

The development of this immunity is most evident in highly endemic areas where people are completely unprotected against almost nightly infection At a cost of high infant and child malaria death rates these people succeed in 10 to 15 years in developing a marked immunity to malaria It is manifest by absence of severe clinical attacks among adults and prevalence of infected persons with no symptoms This immunity is however not absolute in fact one can almost always find adult cases of clinical malaria in highly endemic areas

This immunity results because of certain cells called macrophages as well as the production of special kind of proteins called immunoglobulins which are the antibodies The cells are normally found in the spleen liver and bone marrow etc They are meant to engulf and digest foreign material from the blood stream With repeated attacks of malaria these cells increase in number and their activity

Ths exoerythrocytic stages of malarial infection do not seem to be accompanied by any recognizable

increase of immunity possibly because of the short life of injected sporozoites in the circulation and their subsequent relative isolation in the liver In contrast erythrocytic infections are followed by increased immunoglobulin synthesis and the production of malaria antibodies which can be detected by a variety of immunological techniques The antibodies increase until the crisis and then slowly decline But they are still usually apparent many months after the infection and may reappear in greater density after replases Antibodies against P falciparum may persist for 8 years and against P malaria for upto 26 years but for only 3 years after P vivax A particular type of immunoglobulin called IgG seems to correlate well with malarial infection in man

Vaccination

The concept of immunization against malarial infection is of great potential value in the eventual conquest of the disease just as it is in other com municable diseases This is particularly so in view of the increasing spectrum of drug resistance of parasites to drugs and of mosquitoes to insecticides Making of a vaccine against malaria however, presents technical problems in view of the different stages in the development of the parasite both in man and mosquito Furthermore many species of

11

Prevention of Malaria

Malaria occurs when a female anopheles mosquito which has previously sucked the blood of a patient having malaria parasites subsequently bites another person If either the biting mosquito or the malaria *parasite be eliminated malaria would not occur*

In order to check the bite of a mosquito either the mosquito should be eliminated or the person protected against its bite

The number of mosquitoes present in an area can be controlled by either preventing the mosquitoes from breeding or by killing the adult ones

In actual practice all the three above mentioned

measures need to be taken so that human beings are protected from the mosquito bite These are

(1) Control of mosquito breeding
(2) Control of adult mosquitoes and
(3) Protection against mosquito bite

Let us see how these three measures can be *implemented*

(1) Control of Mosquito Breeding

The intention in preventing mosquito breeding is to limit the number of adult mosquitoes hatching out

The measures adopted for controlling breeding of mosquitoes can be categorised under the following heads

A Elimination of breeding places
B Oiling over the breeding places
C Use of Paris Green
D Use of synthetic insecticides
E *Biological control of mosquito breeding*

We shall take up each of these measures individually

A Elimination of Breeding Places

The ancient Greeks and Romans drained marshes empirically in order to be rid of noxious vapours which seemed to cause chills and fevers Drainage of

breeding places of mosquitoes is still the most important measure to check their breeding

A great part of malaria and particularly of the epidemic form has been due to the neglect or ignorance of man who has time and again created breeding places for mosquitoes These places have been created through interference with drainage lines the creation of pools such as burrow pits often in great abundance the impounding of water in reservoirs, its wide distribution typically in irrigation projects, and the creation of miscellaneous collections such as seepages waste water collection and cart tracks in the villages

Perhaps the most important activity in this connection is modification of drainage lines in the construction of roads railways and canals The embankments on which they stand restrict the flow of water Its prevention lies in the provision of sufficient and adequate culverts set low enough below surrounding ground level to provide a run off for water This type of construction is also usually accompanied by the construction of innumerable burrow pits separated from each other

Areas so low that they cannot be drained by simple run off ditches may require pumping Small portable pumps are used for the purpose in and around the city The water is pumped either into a ditch or out over a wide flat area where it will evaporate or be

absorbed before becoming a breeding place of mosquitoes Such mosquito control is however only a temporary expedient Filling of the depressions where water collects is a more permanent measure

Some epidemics of malaria in Delhi have been reported among the inhabitants of the slums that formed where multi storeyed construction was going on Mosquito breeding has been known to occur in the water which is either intentionally collected or gets inadvertantly collected in such places

In and around the cities the largest number of places where the mosquitoes breed are the desert coolers in the houses which are left unused full of water when the rainy season starts Thousands of breeding places for the mosquitoes are thus provided over which the health authorities have little control This has to be individually looked into by each householder for the care of his or her own health as well as of the neighbours

Breeding of mosquitoes can occur in innumerable small undisturbed places where water is left undrained e g in flower vases inside the house on the roof tops and in places around the house It is the duty of all of us to see that this does not happen

B Oiling Over the Breeding Places

Oil is a rapid destroyer of mosquito larvae and pupae When applied on water it spreads a [illegible]

spray and in the rural areas with synthetic insecticides like D D T, B H C deildrin lindane and malathion These insecticides are sprayed on walls and ceilings of human dwellings and cattle sheds where the mosquitoes are likely to rest

Resistance to these compounds has become common among the mosquitoes

Resistance of the mosquitoes to D D T has been reported and also it has been reported that its cumu lative effect is toxic to human beings and other animal life Yet in the absence of an ideal insecticide which is less expensive adequately effective with long lasting action D D T is the one which is still depended upon to do the job An eminent malariolo gist has stated that D D T today is like a rather rich but erratic aunt We know all about her deeds and misdeeds but we still prefer to have her because she has been so good to us in the past and still provides us an effective insurance against disaster in the immediate future D D T in spite of all that is said against it in affluent countries continues to be the main reliable weapon against vector borne disease, like malaria, in developing countries

Frequent spraying inside the houses with flit and allied preparations checks the number of mosquitoes inside the houses

Pyrethrum sprays inside the houses are effective only for a short while ,D D T and allied sprays are

effective for a much longer time because of their residual effect

In recent years genetic methods have shown promise for the control of mosquitoes in laboratory and field trials The genetic method used is the sterile male technique The male mosquitoes are sterilised in the pupal stage by exposure to gamma radiation or to chemicals The sterilised males are released in large number exceeding the males in a natural population They compete successfully for local females whose eggs fail to hatch resulting in the control or eradication of the species This method has certain advantages over chemical methods being cheaper and potentially more efficient and above all not subject to vector resistance But it is difficult or almost impossible in a huge country like India

Lessening the number of mosquitoes in our surroundings is a sure method of lessening the incidence of malaria

Protection Against Mosquito Bites

Different methods are recommended for the purpose

A Wearing Protective Clothing Veiling the head as a measure of protection from mosquito bite has been helpful in some areas *Sarongs* or pillow slips are effective temporary leg covers for thwarting mosquitoes It is said that they were at one time regularly

Such specifications have not yet been met although many substances have been tested The fact that so many chemicals have been tried suggests at once that none of them proved satisfactory

Certain new products have been developed which are much more useful than any of the older materi als Diethyltoluamide has been found to be an outstanding one others are Indalone dimethyla ph thalate dimethyl carbate ethyl hexamediol etc They are fairly effective for upto a maximum of three to four hours

The most commonly available material in India is dimethyl phthalate which is made up into cream

Use of mosquito repellant cream is liable to give a false sense of protection Applied at 9 or 10 p m its action is likely to last for roughly three hours By that time the anopheles mosquito is most active in its biting activity and it can bite the person when he is sound asleep unless he gets up and applies the cream again It may be remembered that ano pheles comes quietly and causes hardly any incon venience to the person even immediately after the bite

The best protection from mosquito bite at night is the use of proper mosquito net

12

Problems in Malaria Control

At present there are two major problems in malaria control They are (1) Resistance of malaria parasites to some of the potent anti malaria drugs and (2) Resistance of the malaria carrying mosquitoes to many of the available insecticides Both these factors are the cause of current pessimistic outlook in malaria control

Drug Resistance

Resistance of malaria parasites to an anti malarial drug is the ability of the particular parasite species

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Hippocrates and some other Greek and Roman scholars associated malaria with marshy areas and said that it was caused by the bad air arising from the stagnant water in the marshes Later a Roman named Palladius, confirmed that the draining away of the marshes reduced the incidence of malarial fevers He had even suggested that the disease might be caused by drinking water containing mosquito larvae

Early in the nineteenth century when medical scientists examined under the microscope blood from patients suffering from malaria they noticed the presence of a large number of minute black specks In 1878 Alphonse Laveran a French doctor serving with the army in Algeria noted that occasionally in the red blood cells of malaria patients there was a tiny pulsating colourless blob around whose edges the black specks emerged

These observations of Laveran were useful in that they indicated an association between these organisms and malaria But how did this organism get into the patient s blood was not known at all Examination of the stagnant water from the ponds and ditches revealed no sign of it

During the last quarter of the nineteenth century, there were scores of scientists in various countries, working on the problem of malaria transmission Ronald Ross working in India succeeded in unveil

ng this mystery The story of his researches is very interesting indeed

Ross started work on the study of malaria in 1890, but till 1897 he had no success Meanwhile, he worked with and consulted top ranking parasitologists of the world

In 1897, after his return from England Ross set to work at Secunderabad He detected malaria organisms in some patients admitted in the hospital He surrounded these patients with nets and released mosquitoes within After the mosquitoes had drawn blood he captured and dissected them with a view to discovering the parasites within He frantically laboured at this job in the summer heat of Secunderabad Examination of each of the mosquitoes took him two three hours of intense peering through the microscope Of this stage of his researches he wrote The screws of microscope were rusted with sweat from my forehead and hands and its last remaining eye piece was cracked Search for the parasite inside the body of the mosquito was a tedious and time consuming task Ross wrote that under a microscope a mosquito appears as big as hippopotamus is to the naked eye and the object I am looking for need not necessarily be longer than say a nut or an apple and moreover he had no idea at all as to the position the parasite would take up in the enormous mass of cells of which

mosquito is composed

On 20th August 1897 while Ross was tired and his eyes were hurting he decided to look at the last but one specimen He took the stomach out and searched the remainder of the body and again found nothing He could scarcely bring himself to look at the numerous cells of the stomach tissue which under the microscope looked like a collection of flagstones He had done it a thousand times before without any convincing result He wrote But the Angel of Fate fortunately laid his hand on my head He saw a circular object which could not be one of the cells of the stomach tissue of the mosquito In it were black granules exactly like those seen in the malarial blood It at once dawned upon him that the organisms associated with malaria had gone into the walls of the mosquito s stomach He laughed and shouted for his assistant but he had gone for his siesta No No Ross cried to himself *Dame Nature you are a sorceress but you do not* trick me so easily

The same day Ross wrote the following poem

This day designing God
Hath put into my hand
A wonderous thing And God
Be praised At this command
I have *found thy secret deeds*

Oh million murdering Death
I know that this little thing
A million men will save
On Death where is thy sting?
Thy victory Oh grave

In 1898 Ross confirmed and furthered his researches of malaria

Ross achieved success in spite of all the difficulties and hurdles put in his way Nearly all of his medical colleagues in India regarded him as a crank, flying in the face of thousands of years of authority which laid down that malaria was due to bad air from marshes They regarded his passion for mosquitoes as a crazy idea His officers also thought likewise so much so that he was usually the last to be promoted and was always on the lowest rung of the salary scale His requests for special leave to pursue his research were rejected while a colleague was granted six months leave for training of race horses!

At long last the value of his researches was recognized In 1902 Ross was awarded the Nobel Prize for Medicine for his researches on malaria

The researches on malaria after the work of Ross were mainly directed to finding out ways and means of controlling malaria

In 1908 a devastating epidemic of malaria occurred in the Punjab and Uttar Pradesh which caused 307,316 deaths in two months In 1910 the Central Malaria Bureau was founded which was later desig-

14

What Can You Do To Prevent Malaria

Without the cooperation of all of us the malaria problem cannot be solved Whatever the Govern ment may do if cooperation of the people is not available *malaria will continue to menace us*

The following are the important precautions for all of us to observe in order to minimize the incidence of malaria around us

1 Eliminate breeding places of mosquitoes

See that air cooler and its water tank has no water in it when the cooler is not in use

The water tank of the air conditioner should not contain any water when it is not being used

Water in the flower vases kept inside the house be changed at least once a week

Discarded tins and other household materials kept on roof top or in any other open place where rain water can collect in them must be properly disposed of

Choked up drains near the houses may be reported to the municipal authorities to be cleaned

Fill either individually or collectively or insist upon the municipal authorities to fill pits burrows or ponds near your house

Ask the municipal health officer to arrange for oiling over the stagnant water which cannot be removed immediately

2 Destroy the Mosquito

Use flit or other similar sprays in your houses if mosquitoes are around

Request the municipal health officer to arrange to do pyrethrum spraying inside your house

3 Protect yourself from mosquito bite

Use mosquito nets at night if you live in an area where there are mosquitoes and malaria also occurs

4 Visit Malaria Clinic when necessary

Inform or visit malaria clinic nearest to house in case there is a case of fever T present over one hundred Malaria Clinics in working within the precincts of different or outside Similar clinics are available in cities as well These clinics provide both ^ and treatment facilities free Cases reported also help in assessing whether malaria is or decreasing in an area and whether the rial measures being taken are effective or not

5 Get treated promptly

By getting treated promptly when you do malaria you not only protect yourself from its ges but protect others also in the process W take prompt treatment you not only kill the of development of malaria parasites in your which caused the fever but also those which infect a mosquito—the gametocytes Thus, the cycle of man mosquito man malaria

6 Inform as many people as possible about mentioned measures to control malaria

By Helping TO Control Malaria You Not O Others But Also Help Yourself and Your F